

Production Technology of Fruits

Included Fruits

Mango

Guava

Banana

Litchi

Papaya

Jujube

Book: Handbook of Agricultural Technology

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VI. FRUIT CROPS

Among all kinds of food in the plant kingdom fruit is perhaps the most original one that the people of pre-historic ages depended almost entirely on it. Fruits are the most delicious natural or uncooked food. It is only the fruits whose food value has not been impaired by cooking before they reach the stomachs. Fruits have the least possibility of being contaminated or adulterated naturally which can be eaten almost anywhere, in any form and by anybody without being hesitant about their purity or cleanliness. Fruits are not only ready-made delicious food but they are also valued for their vitamins and mineral contents. Many fruits are extra-ordinary source of vitamin C and A. In addition, some fruits contain vitamin B, iron and some has high caloric value. Many fruits have high energy values too and so on. However, BARI has developed a good number of high yielding varieties of different fruits along with improved production technologies. Among them, the most important fruit crops in Bangladesh are described below.

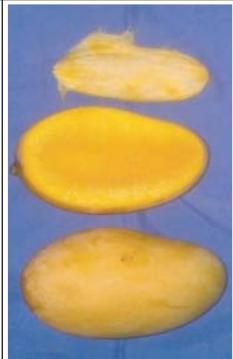
1. Mango

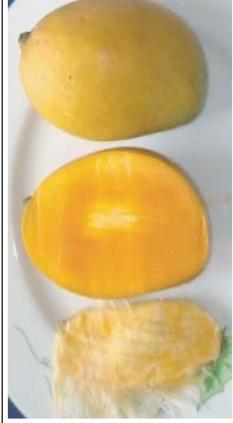
Mango is the most popular and tasty fruit in Bangladesh. It is called the king of fruits. It is a national tree of Bangladesh. Mango is cultivated in almost all districts of Bangladesh. But a good quality and high value mango is grown well in the districts of north-western and south-western region because of soil and weather condition. It is a main source of income of many people of those areas. But now-a-days, mango is cultivated commercially in all districts of Bangladesh in addition to those mentioned areas due to introduction of high yielding mango varieties. At present, the total area and production of mango is 27.5 thousand hectares and 8.89 lac metric tons, respectively (BBS, 2011). Different kinds of taste, scent, nutrient value and uses of mango are not comparable to any other fruits. Ripened mango contains adequate quantity of carotene or vitamin A and minerals. It ranks top of the list among all fruits of the world in respect of vitamin A content.

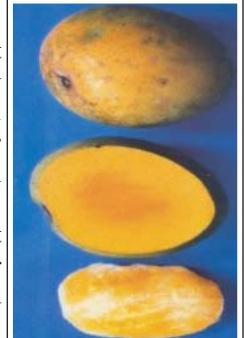
1.1 Varieties

BARI developed 10 (ten) mango varieties and their important features are given below:

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Aam-1 (1996)	High yielding, early and regular bearer variety. Plants are big tree, dome shaped, spreading and moderately vigorous. It flowers in mid-January; fruits are set in mid-February and harvested in late May. Fruits are medium, individual fruit weight: 200g, round shaped and coloured. The average length, breadth and thickness of fruit are 7.6, 6.7 and 5.9 cm respectively. Flesh colour orange, texture firm, abundantly juicy; edible portion: 71%. TSS 20%; fibre absent. The number of fruits in each plant: 1000-1100. Taste of fruit is excellent having good keeping quality. Tolerant to common insect pests and diseases of mango. The variety possesses export potentiality and country wide adaptability. Fruit yield: 20-22 t/ha.	

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Aam-2 (1996)	High yielding mid-season, regular bearing, coloured variety. Plants are medium sized tree, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid-February and harvested in late June. Fruits are medium and each fruit weight: 250g and oblong in shape. The average length, breadth and thickness of fruit are 9.75, 7.25 and 6.10 cm respectively. Pulp is yellow in colour, medium juicy and medium sweet (17.5% TSS); edible portion: 69%. Fibre absent. Tolerant to common insect pests and diseases of mango. The variety possesses export potentiality and country wide adaptability. Fruit yield: 20-26 t/ha.	
BARI Aam-3 (1996)	High yielding, late and regular bearer exotic variety. Plants are medium, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid-February and harvested in late June to early July. Fruits are big (600g) and individual fruit weight: 215g, ovate-oblong in shape. The average length, breadth and thickness of fruit is 8.3 cm, 6.0 cm and 5.8 cm, respectively. Pulp is soft, deep yellow in colour, fibreless, very juicy, pleasant flavour and very sweet (23.4% TSS). Tolerant to common insect pests and diseases of mango. Edible portion: 71% and country wide adaptability. Fruit yield: 18-22 t/ha.	
BARI Aam-4 (Hybrid) (2002)	High yielding, regular bearing and late hybrid variety (Ashwina x M-3896) of mango. Plants are medium sized tree, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid-February and harvested in late July to early August. Fruits are big and each fruit weight: 600g; round shaped and greenish yellow in colour. Pulp is soft in texture, yellow in colour, medium juicy, fibreless and very sweet (24.5% TSS) having pleasant flavour. Edible portion: 80%. Tolerant to common insect pests and diseases of mango. The variety possesses country wide adaptability. Fruit yield: 15-16 t/ha.	
BARI Aam-5 (2009)	High yielding, regular bearing and early season variety. Plants are big tree, dome shaped, spreading and moderately vigorous. It flowers in mid-January; fruits are set in mid February and harvested in late May. Fruits are medium and its weight: 230g, elliptic in shape and bright yellow in colour. Pulp is firm, medium juicy, fibreless, and sweet (19.0% TSS) having pleasant flavour. Edible portion: 70%. Tolerant to common insect pests and diseases of mango. This variety is mainly suitable for south-western region. It possesses export potentiality. Fruit yield: 15-20 t/ha.	

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Aam-6 (2009)	This variety was identified by BARI through "National Mango Show 1993". Locally this variety is known as "Bou Bhulani". High yielding, mid-season, regular bearing variety. Plants are medium sized tree, dome shaped, spreading and moderately vigorous. It flowers in mid January; fruits are set in mid-February and harvested in the last week of June. Fruits are medium and each fruit weight: 280g, elliptic in shape and yellowish green in colour. The average length, breadth and thickness of fruit are 9.9, 9.5 and 11.3 cm respectively. Pulp is soft, medium juicy, fibreless, yellow in colour and sweet (21% TSS). Edible portion: 71%. Tolerant to common insect pests and diseases of mango. Good storage ability. This variety is mainly suitable for north-western region. Fruit yield: 8-10 t/ha.	
BARI Aam-7 (2009)	High yielding, mid to late season, regular bearing coloured variety. Plants are big trees, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid-February and harvested in late June. The average length, breadth and thickness of fruits are 9.5, 8.1 and 6.2 cm, respectively. Fruits are medium and individual fruit weight: 285g, roundish in shape having attractive yellow skin colour with red tinge. Pulp is soft, medium juicy, fibreless, yellow in colour and medium sweet (18.0% TSS). Tolerant to common insect pests and diseases of mango. Edible portion: 77%. Fruit yield: 18-20 t/ha.	
BARI Aam-8 (2009)	High yielding, late season, regular bearing, poly-embryonic variety. Plants are medium sized tree, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid-February and harvested in early July. Fruits are medium and each fruit weight: 270 g. Number of fruits per tree: 500-600 and their weight: 135-162 kg in different locations; oblong in shape and bright yellow in colour at ripen stage. The average length, breadth and thickness of fruit are 11.3 cm, 7.0 cm and 6.0 cm, respectively. Pulp is soft, juicy, fibreless, bright yellow in colour and very sweet (22% TSS). Edible portion: 70%. Tolerant to common insect pests and diseases of mango. Good storage ability. Adaptable in all areas of Bangladesh. Four to five true to type saplings can be obtained from one stone. Fruit yield: 13.5-16.2 t/ha in 8 years old trees.	
BARI Aam-9 (2011)	Moderately high yielding, regular bearer and early Kanchamitha (sweet in green stage) variety. Plants are big trees, dome shaped, spreading and vigorous. Flowering time is mid-January and harvesting time of fruit at green stage is early May. Fruits are small sized and its weight: 166g, ellipsoid in shape and green in colour at edible unripe stage. Fruits are sweet in green stage (kancha mitha). Seeds are small, edible portion: 68% and medium sweet (TSS 11%) at green edible stage. It is suitable for north-western region particularly in greater Rajshahi. Fruit yield: 1.35 t/ha. in three years old tree.	

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Aam-10 (2012)	High yielding, early and regular bearer. Plants are big trees, dome shaped, spreading and moderately vigorous. It flowers in mid to late January; fruits are set in mid February and harvested in first fortnight of June. Fruits are medium and individual fruit weight: 200g. Number of fruits per tree: 800-1000 and their weight: 160-200 kg; roundish in shape and yellowish green in colour and sweet (TSS 18.0%). Edible portion: 65%. Tolerant to common insect pests and diseases of mango. It is recommended for cultivation in high rain prone areas of north-eastern and eastern region. Fruit yield: 15-20 t/ha.	

1.2 Production Technology

Land and soil

High and medium high land should be selected for planting mango trees. In hilly areas, the hill slopes should be below 45°. Mango can be grown almost in all kinds of soil, but the most desirable soil is one which is of medium texture, that is deep and well drained and has a pH range of 5.5 to 7.5 and a water table below 180 cm round the year.

Time of transplanting

May to mid-July is the best period for transplanting mango sapling. If irrigation facilities are available and planting materials are in hand, transplanting in spring and early summer from March to April may be suitable.

Sapling collection

For planting, mango sapling should be the graft of an ideal variety. The graft should be healthy, strong and disease free. The grafts should be collected from a reliable nursery or from Government farm.

Transplanting method

Spacing: The planting distance varies with variety, fertility level of the soil and general growing conditions in the area. If the growth is vigorous, the distance should be 12m x 12m, but where the growth is less, it can be reduced to about 10m x 10m. For dwarf variety (like BARI Aam-3) 8m x 8m distance is sufficient.

Pit preparation: The pit should be of at least 1m x 1m x 1m in size. The pit should remain exposed for 10 to 15 days before it is filled with soil, manure and fertilizer. The pit needs to be filled with 20kg well rotten cowdung or compost, 500g TSP, 250g MP, 250g gypsum and 50g zinc sulphate. The soil of the pit needs to be watered if the soil is dry during pit filling.

Transplanting: Transplanting of healthy, strong and disease free mango sampling has to be done at 10 to 15 days after the pit filling with soil-fertilizer mixture. The sapling with its root ball of earth should be taken out of the soil, poly-bag or pot intact. The sapling is

then placed in the centre of the pit excavating as much soil as necessary to accommodate the root ball. After planting, the soil around the plant is firmly pressed and irrigated immediately after planting. A stake must be pegged at one side, and sapling is then tied to the stake with rope keeping some distance between stake and sapling.

Fertilizer dose and application method

The nutritional requirements vary with the region depending upon the type of soil and age of the tree. The year to year dosage of fertilizer is given below:

Manure and Fertilizers	Age of plant, (years)					
	2 - 4	5 - 7	8 - 10	11 - 15	16 - 20	> 20
Cowdung or compost (kg)	10 - 15	16 - 20	21 - 25	26 - 30	31 - 40	41 - 50
Urea (g)	250	500	750	1000	1500	2000
TSP (g)	250	250	500	500	750	1000
MP (g)	100	200	250	350	450	500
Gypsum (g)	100	200	250	350	400	500
Zinc sulfate (g)	10	10	15	15	20	25
Boric acid (g)	20	20	30	30	40	50

Fertilizers are to be applied in two split doses, one half immediately after harvesting of the fruits in June-July and the other half in September-October at the end of rainy season. The manure and fertilizer should be duly placed into the ground in trenches that may be 30 cm wide, 15-20 cm deep and 30 cm away from the base of a one year old plant. In this manner, the circular trench/canal around the tree may have to make 2-3 m away from the trunk in 10-12 years and 4 m away in about 30 years old trees. The manure and fertilizer should be applied evenly in the circular canal/trench which is then back filled in with soil.

The manure and fertilizer may also be applied by spading or ploughing the soil around the plant up to the area shaded by the plant at noon. The manure and fertilizers should be spread all over but 1 m away from the trunk and then mixed with soil by spading or ploughing up to a depth of 15 cm. There must be an irrigation of the soil after each application of fertilizer whether the same is spread over the surface or in the trenches.

Irrigation

Number and frequency of irrigations depend upon the type of soil, climatic conditions especially rainfall and its distribution and age of trees. The need for irrigation arises higher during drier part of the year from November to April and lesser in summer (May-June). The clay or heavier soils needs to be irrigated less frequently than the lighter soils (e.g. sandy loam). Depending on all these factors, plants up to the age of six months may need to be irrigated at an interval of 2-6 days, plants between 6 and 18 months may be irrigated after every 4-12 days, and those aged 1.5-5.0 years may need irrigation at an interval of 1-3 weeks. When the trees are in full bearing stage, generally two irrigations are needed in modified basin method-one at full bloom and another at pea stage of fruit. This is helpful in reducing fruit drop and improving fruit size. In modified basin method dike should be constructed around each tree to prevent water run-off during irrigation.

Irrigation may be applied in hole system also. In this system, dig four 20 cm deep and 15 cm wide holes 1.5 to 2 m away from the trunk and fill the holes first to capacity with water. After filling the last few holes, water poured earlier will be dried and the holes should be filled again. Beside these methods, orchard may be irrigated through flooding. However, for obtaining good flowering one must stop irrigation at least 2-3 months before the flowering period. Irrigation during this period is likely to promote vegetative growth, which will be detrimental to flowering.

1.3 Intercultural Operation

Ploughing: The orchard should be ploughed two times in a year-first operation should be done before the onset of rainy season. This helps checking run-off losses and facilitate maximum intake of water into the soil, and suppressing weed. Orchards may be ploughed again after the rainy season is over so as to suppress the weed growth and also to break capillaries.

Training and Pruning: Normally mango trees require very less or no pruning. However, the training of the plants in the initial stages (2-3 years) is very essential to give them a proper shape. At least 100 cm of the main trunk should be kept free from branching. Moreover, it is advisable to keep a watch on the development of shoots from the rootstock. Such a shoot or growth leads to a branch that bears the characteristics of the rootstock which is of seedling origin and is not desirable. This kind of shoot must be eliminated soon after its detection.

Removal of panicle: The grafted plants of mango often produce some flowers in the same year of planting or before attaining sufficient vegetative growth. These flowers should be pinched off for the first 3 years to provide proper vegetative growth as well as for developing a good framework of the plant.

Pest Management

Major insects and control measures:

Name of insect	Control measures	
	Name of pesticides /treatment	Rate per litre of water
Mango hopper	Cypermethrin (Cymbush/Basathrin /Fenom) 10 EC or Sumicidin 20 EC or Decis 2.5 EC	1.5 ml/l At panicle emergence (4-6") and at fruit set (pea) stage
Mango fruit fly	Or Bait trap	1 g Dipterex 80sp or Secufon 80 SP + 100 g mashed ripe mango pulp + 100 ml water (1 trap per tree)
	Or Decis 2.5 EC	1 ml/l
	Or Methyl eugenol sex pheromone trap	1 trap per tree
Mango fruit weevil	Fenitrothion (Sumithion /Lithion/Fenitox) 50 EC	2 ml/l
Mango defoliator	Dichlorovos (Vapona /Phosvit) 100 EC	2.5 ml/l
Mango leaf cutting weevil	Cypermethrin (Ripcord/Cymbush/ Basathrin /Fenom) 10 EC	1.5 ml/l

Major diseases and control measures:

Name of disease	Control measures	
	Name of pesticide /treatment	Rate per litre of water
Anthracnose	Indofil M-45	2 g/l . At panicle emergence (4-6") and at fruit set (pea) stage
	Or Tilt 250 EC	0.5 ml/l. At panicle emergence (4-6") and at fruit set (pea) stage
Die-back	Indofil M-45	2 g/l
	Or Bordeaux mixture (copper sulphate + lime)	1%
Powdery mildew	Thiovit or Wettable sulfur	2 g/l
	Or Tilt 250 EC	0.5 ml/l
	Or Bavistin	1 g/l . 2-3 spray-first one before flower opening and other two after fruit set
Sooty mould	Thiovit	2g/l
Red rust	Bordeaux mixture	1%
	Or Copper oxychloride	3 g/l
	Or Cupravit	1 g/l
Stem end rot/post harvest anthracnose	Indofil M-45	2 g/l
	Or Hot water treatment	Soaking of freshly harvested fruit in hot water (55°C) for 5 minutes

1.4 Harvesting and Fruit preservation

The various criteria recommended for judging maturity are (i) slight colour development on the shoulders, (ii) when one or two ripe fruits fall from the plant naturally, and (iii) when the specific gravity of fruits ranges between 1.01 and 1.02. This method is more dependable. For this, fruit samples from various parts of the tree are taken and dropped in a bucket of water; if the fruits are mature they will submerge completely in the water. Number of days taken by the fruit to mature depends on the variety and the climatic conditions and, hence it cannot serve as a guide. However, in general, fruits mature between 90 to 130 days from the fruit-set stage.

Fruits should not be picked by shaking the branches and making them fall on the ground. There should be neither a bruise on the skin nor a shattering of the fruit. If possible, the fruits should be picked by hand. For most trees, therefore, a bamboo pole harvester has to be used. This harvester has an iron blade at its edge and a net-bag below it. When the fruit-stalk is snapped by the blade, the fruit fall into the bag. Harvested fruits are heaped under the tree on rice straw or on mango leaves for a while.

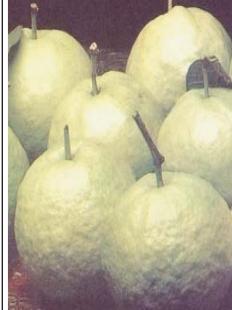
The harvested fruits should first be graded according to size and appearance before marketing and storage. Ripe fruits and damaged fruits of relatively poor quality are usually retained for local markets and better types which are still remaining green and hard are packed for distance places. Fruits of each grade are to be packed separately in a container that should indicate at its top the variety, size, number of fruits and consignee's address. Bamboo baskets are of common use in Bangladesh. Rice straw is a very suitable material for placing around the fruits inside the basket. In recent days, plastic crates are becoming popular for transporting mango.

2. Guava

Guava is a very popular fruit with enrichment of vitamin C. This crop is grown more or less everywhere in Bangladesh. At present, Guava is commercially cultivated in most of the regions of Bangladesh after developing high yielding guava varieties. Presently, its area and production, respectively is 4.88 thousand hectares and 2.71 lac metric tons in Bangladesh (BBS, 2011). Guava is, often called as Apple particularly in the region of Sub-tropical countries for its many roles. Fresh, green guava is eaten by the people. Besides this Jam, Jelly and juice are made from guava through different processing.

2.1 Varieties

BARI developed 3 (three) guava varieties and their important characteristics are given below:

Name of Varieties (Year of Release)	Important Characteristics	Crop
Kazi Peyara (1984)	High yielding variety produces fruit twice a year. The plants are dwarf, spreading and moderately dense. In the main season, it flowers during March-April and the fruit are harvested in July-August. The other season, it flowers in September and the fruits are harvested in February. Average fruit weight: 450g. Fruit are pear to roundish in shape, smooth and shiny, yellowish green at ripen, white fleshed, crispy in texture and sour-sweet in taste (8% TSS). It is less seeded variety contains 109 seeds per 100g fruit. Fruit contain 202 mg vitamin C/100g of flesh. It can be stored well for 10 days at room temperature. Country wide adaptability. Fruit yield: 28-30 t/ha.	
BARI Peyara-2 (1996)	High yielding variety produces fruit almost round the year. The plants are dwarf, spreading and moderately dense. In the main season, it flowers during March-April and the fruits are harvested in July-August. The other season, it flowers during September and the fruits are harvested during winter season (February). Fruit are round, fruit weight: 400g, rough and shiny surface, yellowish green at ripen, white fleshed, less seeded, crispy, juicy and sweet in taste (10% TSS). It can be stored upto 12 days at room temperature. Country wide adaptability. Suitable for homestead. Sensitive to anthracnose, wilt and fruit fly. Fruit yield: 30-35 t/ha.	
BARI Peyara-3 (2003)	High yielding, regular bearer and pink fleshed variety. The plants are medium in size, spreading and moderately dense. It flowers during March-April and the fruits are harvested in September. Fruit are medium (180g each) in size, globose in shape, red fleshed, soft, medium crispy and slightly sour (7% TSS) in taste. Seeds are small and medium hard. Attractive pink coloured tasty juice can be prepared from the fruit. Suitable for processing (making jelly). This variety is mostly preferred by hill people. It is recommended for cultivation in hill region. Fruit yield: 20-22 t/ha. But yield potential 12.25 t/ha from 5 years old tree.	

2.2 Production Technology

Land and soil

Guava trees are very hardy and can thrive on all types of soil provided that the roots have access to a constant supply of water but they are sensitive to water logging. For best production, guava should be grown in deep, well drained soils, high in organic matter. The crop is fairly salt and drought resistant and the P^H may range from 4.5 to 8.2. High and medium high land should be selected for planting guava trees. In hilly areas, the hill slopes should be below 45°.

Time of transplanting

The planting of guava should be done when the weather is neither too wet nor too dry. The best planting time is May-June which might help in the establishment of young plants. Planting may also be done after the rainy season i.e. August-September. Where there is a scope of irrigation, guava saplings can be planted round the year.

Sapling collection

Guava can be propagated through sexual and asexual means. Air layering (or marcottage) and seeds are commonly used for propagation of guava. Guava sapling should be of an ideal variety. The sapling should be healthy, strong and disease free, and should be collected from a reliable nursery or from Government farm.

Transplanting method

Spacing: The planting distance varies with variety, fertility level of the soil and general growing conditions in the area. For Kazi Peyara and BARI Peyara-2.5m x 5m spacing but for BARI Peyara-3 and some local cultivars, 6m x 6m distance is required. Before planting, the field should be deeply ploughed, harrowed and levelled.

Pit preparation: The pits of about 60 cm x 60 cm x 45 cm should be dug in hexagonal or square system of planting. The contour system is followed in hilly areas. The pit should be of at least 60cm x 60 cm x 45 cm in size. The pit should remain exposed for 10 to 15 days before it is filled with soil, manure and fertilizer. The pit needs to be filled with 15-20kg well rotten cowdung or compost, 250g TSP, 250g MP, 100g gypsum and 25g zinc sulphate. The soil of the pit needs to be watered if the soil is dry during pit filling.

Transplanting: At the planting time a small hole is made at the centre of the refilled pit and the desired air-layer/seedling is planted. Water should be applied immediately after planting. Staking and fencing are also necessary.

Fertilizer dose and application method

The nutritional requirements vary with region depending upon the type of soil and age of tree. The year to year dosage of fertilizer is indicated below.

Requirements of manures and fertilizers of guava (year to year fertilizer doses) are as follows:

Manure and Fertilizers	Age of plant, (year)				
	1-2	3-4	4-5	5-6	> 6
Cowdung (kg)	10 - 15	16 - 20	21 – 25	26 - 30	40
Urea (g)	100	200	300	400	500
TSP (g)	100	200	300	400	500
MP (g)	100	200	300	400	500
Gypsum (g)	50	100	150	200	200
Zinc sulphate (g)	5	10	10	15	20
Boric acid (g)	5	10	10	15	20

Fertilizers should be applied in three split doses, one third is immediately after harvesting of the fruits in September-October, other one third is in February at the end of winter season, and the last installment is at the time of fruit sett (April-May).

The manures and fertilizers should be duly placed into the ground in trenches that may be 30 cm wide, 10-15 cm deep and 30 cm away from the base of a one year old plant. In this manner, the circular trench/canal around the tree may have to be made 1-2m away from the trunk in 5-6 years. The manures and fertilizers should be applied evenly in the canal/trench which is then back filled in with soil.

The manures and fertilizers may also be applied by spading or ploughing the soil around the plant up to the area shaded by the plant at noon. The manure and fertilizers should be spread all over but 50 cm away from the trunk and then mixed with soil by spading or ploughing up to a depth of 10-15 cm. There must be an irrigation of the soil after each application of fertilizers whether the same is spread over the surface or in the trenches.

Irrigation

Irrigation is essential before flowering, during fruit setting and development since during this period the soil moisture and atmospheric humidity remains very low. At the time of flowering, the temperature in most of the region in Bangladesh remains within 30-35°C causing high transpiration. Generally, no irrigation is given to bearing trees as a result of which moisture stress due to prolonged period of drought causes yield reduction through fruit drop. Young plants also suffer due to shortage of water resulting poor growth and even death. Irrigation of young trees should be done by basin system. The full grown trees are irrigated by flooding or by furrow system. Irrigation at fortnightly interval after fruit set gives good harvest. Irrigation is also essential after the application of fertilizers.

2.3 Intercultural Operation

Ploughing: The orchard should be ploughed two times in a year-first operation should be done before the onset of rainy season. This helps checking run-off losses and facilitating maximum intake of water into the soil, and suppressing weed. Orchards may be ploughed again after the rainy season is over so as to suppress the weed growth and also to break the capillaries.

Training and pruning: The main objective of training guava plants is to provide a strong framework and scaffold of branches suitable for bearing a heavy remunerative crop without damaging the branches. The system of training is open centre, in which the plants are headed back. Primary shoots are retained for the initial framework which is subsequently pruned by cutting one third to half of their length after 3 months. After making the initial

framework, the two side shoots are permitted to grow initially and after 3-4 years, doubling of selected branches is continued. As the flowers and fruits are borne on current season growth, thinning out, i.e. a light annual pruning is considered beneficial to encourage new shoots after the harvest. All dead, diseased, unproductive branches, crowded shoots and water sprouts should be pruned back annually.

Fruit bagging: Bagging of fruits at an early stage of development has been found most effective against insect and disease infestation. It also protects the fruits from bird and bat damage. Moreover, there is a good scope of getting more return with the production of good looking fruits of good shape and size from bagging. It is, therefore, advocated to practice regularly fruit bagging using brown paper bags. Spraying of fungicide (Tilt 250 EC @ 0.5 ml/L) is essential prior to bagging for controlling anthracnose.

Mulching: Mulching is generally practiced for conserving soil moisture and suppressing weed growth. Dried leaves, straw or water hyacinth are generally used as mulch. The use of mulch would encourage the development of better root system of young guava plants.

Fruit thinning: High yielding cultivars like Kazi Peyara and BARI Peyara-2 bear such heavy crops that many limbs are broken or badly bent. Hence, fruit thinning should be done in such a way that the tree will retain one fruit for every 50 leaves. Normally 2-3 fruits are borne in one cluster. Only one fruit should be allowed to develop per cluster. Fruit thinning in the main season promote fruit bearing in the off-season.

Pest Management

Major insects and diseases and their control:

Name of pest	Control measures	
	Name of pesticide /treatment	Rate per litre of water
Fruit fly	Bait trap (5g Mipsin 80sp + 100 g mashed banana pulp) or Methyl eugenol sex pheromone trap	1 trap per tree 1 trap per tree
White fly	Powder soap or Liquid soap or Imidachloprid (Admire 200SL/Imitaph 20SL)	5g/l 5 ml/l. At initial stage of infestation 0.5 ml/l. 2-3 spray at 15 days interval
Fruit borer	Clean cultivation Fruit bagging	-
Anthracnose	Knowin 50WP or Tilt 250 EC	2.0 g/l 0.5 ml/l 3-4 spray at 15 days interval starting from marble stage of fruit
Fusarium wilt	Quick drainage Grafting onto resistant rootstock like Poly peyara) Liming with Dolochun	- - 1000 kg/ha

2.4 Harvesting and Seed preservation

The green colour changes to yellowish green or yellow when the fruit ripens. The fruit is harvested in July/August and February/March of the following year. Guava is harvested individually by hand with proper care.

Endocarp with seed is separated from mesocarp and allowed to ferment for 24 hours. Then the mesocarp is mashed and the seeds are extracted washing it in running water. The seeds are dried in room under fan for several days and preserved in air tight bottle.

3. Litchi

Litchi is very popular both in home and abroad for its appealing flavour and taste. Litchi is grown mainly in greater Rajshahi, Dinajpur, Kustia, Jessore, Pabna, Mymensingh and Chittagong districts and Chittagong Hill Tracts. At present, the total area and production of litchi is 1.86 thousand hectares and 66.5 thousand metric tons respectively in Bangladesh (BBS, 2011).

3.1 Varieties

BARI has so far developed 5 (five) high yielding varieties of litchi. A brief description of the varieties along with some important characteristics is given below.

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Lichu-1 (1996)	High yielding, regular bearing, early variety. Plants are big tree, dome shaped, spreading and vigorous. It flowers in mid January; fruit are set in mid February and harvested in mid May. Fruit are oval shaped weighing: 20g each. Its length and breadth are, respectively 3.5 cm and 3.1 cm. It is brick-red in colour, juicy and sweet (18-20% TSS). Edible portion: 65%. Suitable for northern districts particularly in Rajshahi and Pabna region. Fruit yield: 10-12 t/ha.	
BARI Lichu-2 (1996)	High yielding, late maturing, regular bearer variety. Plants are medium tree, dome shaped, spreading and less vigorous. It flowers in late January; fruit are set in mid to late February and harvested in early June. The average length and breadth of fruit is, respectively 3.4 and 3.0 cm. Fruits are roundish weighing: 18g each, pink coloured, juicy and sweet (18% TSS). Edible portion: 68%. The number of fruits in each mature plant: 2300-2700. Tolerant to common insect pests and diseases of litchi. Suitable for eastern region of the country and also performing well in mid and western region. Fruit yield: 8-10 t/ha.	
BARI Lichu-3 (1996)	Mid-season regularly shy bearing, small seeded, good quality and high value variety. Plants are medium tree, dome shaped, spreading and less vigorous. It flowers in late January; fruits are set in mid to late February and harvested in late May. Fruit are heart shaped, weighing: 20-22g, juicy, rose scented and sweet (20% TSS). The average length and breadth of each fruit is 3.0cm and 3.3cm respectively. Edible portion: 76%. The number of fruits in each plant: 1600-2000. Tolerant to common insect pests and diseases of litchi. This variety is suitable for cultivation all over Bangladesh. Fruit yield: 5.0-5.5 t/ha.	

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Lichu-4 (2008)	Mid season high yielding, regular bearing, small seeded, good quality and high value variety. Plants are big trees, dome shaped, spreading and moderately vigorous. It flowers in late January; fruit are set in mid to late February and peak harvesting period: 2nd week of June. Fruit are big weighing: 26g each, globose in juicy. Attractive deep red in colour and white flesh. Pulp is soft, very juicy and very sweet (22% TSS) and pleasant in flavour. The number of fruit in each plant: 5000 and weighing: 130 kg. Very high edible portion: 75%. Tolerant to common insect pests and diseases of litchi. Possess export potentiality. This variety is commercially suitable for cultivation in Dinajpur and Rangpur region. Fruit yield: 10-13 t/ha.	
BARI Lichu-5 (2012)	Late season high yielding, regular bearing variety. Plants are medium tree, dome shaped, spreading and less vigorous. It flowers in late January to early February; fruits are set in mid to late February and harvested in early June. Fruits are medium weighing: 21.8g each. Number of fruit per tree: 3500 and their weight: 73.5 kg. Heart shaped, deep red in colour, very juicy and sweet (17.5% TSS). Edible portion: 73%. Tolerant to common insect pests and diseases of litchi. Possess export potentiality. Suitable for eastern hilly region. Fruit yield: 11.5 t/ha in 15 years old trees.	

3.2 Production Technology

Land and soil

High and medium high land should be selected for planting litchi trees. In hilly areas, the hill slopes should be below 45°. The litchi can be grown in almost all kinds of soil, but performs better in deep well drained loamy soil having pH 6.5-6.8.

Time of transplanting

The planting of litchi should be done when the weather is neither too wet nor too dry. The best planting time is May-June which might help in the establishment of young plants. Planting may also be done after the rainy season i.e. August-September where there is a scope of irrigation.

Sapling collection

Litchi can be propagated through sexual and asexual means. However, air layering (or marcottage) is the most economic and popular method of vegetative propagation. Litchi sapling should be of an ideal variety adaptive to the location. The sapling should be healthy, strong and disease free, and should be collected from a reliable nursery or from Government farm.

Transplanting method

Spacing: The planting distance varies with variety, fertility level of the soil and growing conditions in the area. Where the growth is vigorous, the distance should be 10m x 10m, but where the growth is less, it can be reduced to about 8m x 8m. For dwarf varieties (like BARI Lichu-3) 7m x 7m distance is sufficient.

Pit preparation: The pit should be at least 1m x 1m x 1m in size. The pit should remain exposed for 10 to 15 days before it is filled with soil, manures and fertilizers. The pit needs to be filled with 15-20 kg well rotten cowdung or compost, 500g TSP, 400g MP, 250g gypsum and 50g zinc sulphate. A basket of soil from an old litchi orchard, which contains mycorrhizal fungi, should be added. The soil of the pit needs to be watered if the soil is dry during pit filling.

Transplanting: At the planting time a small hole is made at the centre of the refilled pit and the desired air-layer is planted. Pot plants have a very brittle root system and should be handled carefully to minimize the damage of roots. Water should be applied immediately after planting. Staking and fencing are also necessary. The young litchi plant is very delicate and the mortality rate after planting is high. This is due to non-hardened planting material and lack of proper care at the time of planting and afterwards.

Fertilizer dose and application method

The nutritional requirements vary with region depending upon the type of soil and age of tree. The year to year dosage of fertilizers is indicated below.

Requirement of manures and fertilizers (year to year nutrient doses) are as follows:

Manures and Fertilizers	Age of plant, (year)					
	2 - 4	5 - 7	8 - 10	11 - 15	16 - 20	> 20
Cowdung (kg)	10 - 15	16 - 20	21 - 25	26 - 30	31 - 40	41 - 50
Urea (g)	250	500	750	1000	1500	2000
TSP (g)	500	1000	1500	2000	2500	3000
MP (g)	200	400	750	1000	1250	1500
Gypsum (g)	100	150	200	250	300	400
Zinc sulphate (g)	10	15	20	30	40	50
Boric acid (g)	10	15	20	30	40	50

Fertilizers should be applied in three split doses, one third should be done immediately after harvesting of the fruits in May-June, other one third should be in September- October at the end of rainy season, and the last installment should be at the time of fruit set (February).

The manures and fertilizers should be duly placed into the ground in trenches that may be 30cm wide, 10-15cm deep and 30cm away from the base of a one year old

plant. In this manner, the circular trench/canal around the tree may have to be made 2-3m away from the trunk in 10-12 years and 4m away in about 30 years. The manures and fertilizers should be applied evenly in the canal/trench which is then back filled in with soil.

The manures and fertilizers may also be applied by spading or ploughing the soil around the plant up to the area shaded by the plant at noon. The manures and fertilizers should be spread all over but 1 m away from the trunk and then mixed with soil by spading or ploughing up to a depth of 10-15 cm. There must be an irrigation of the soil after each application of fertilizer whether the same is spread over the surface or in the trenches.

Irrigation

Irrigation is essential during flowering, fruit setting and development since during this period the soil moisture and atmospheric humidity remains very low. At the time of flowering, the temperature in most of the region in Bangladesh remains within 27-28°C, but it increase afterwards and transpiration rises considerably. Generally, no irrigation is given to bearing trees as a result of which moisture stress due to prolonged period of drought causes yield reduction through fruit drop. The fruits which remain do not develop fully and they often split and become unfit for consumption. Young plants also suffer due to shortage of water resulting poor growth and sometimes death. Irrigation of young trees should be done by basin system. The full grown trees are irrigated by flooding or by furrow system. Irrigation afortnightly interval after fruit set gives good harvest. Irrigation should not be provided before flowering of litchi trees. Irrigation is also essential after the application of fertilizers.

3.3 Intercultural Operation

The orchard should be ploughed two times in a year-first operation should be done before the onset of rainy season. This helps checking run-off losses and facilitate maximum intake of water into the soil, and suppressing weed. Orchards may be ploughed again after the rainy season is over so as to suppress the weed growth and also to break capillaries.

Training of litchi plants during the early years is necessary to provide a good framework. Once the desirable shape and strong framework is achieved, no pruning is usually necessary, except the removal of dead or diseased branches and damaged shoots or cross limbs. Since litchi flowers are borne mostly on terminal shoots of current year's growth, and old shoots rarely produce flowers, some pruning to promote new growth, by snipping of old branches appears to be justified. This is done indirectly when a part of the shoot bearing the cluster of fruits is removed during harvesting. Heavy pruning of the tree causes profuse vegetative growth resulting in poor fruiting. In case, the tree is making too much vegetative growth both shoot and root pruning is necessary.

Mulching is generally practiced for conserving soil moisture and suppressing weed growth. Dried leaves, straw or water hyacinth are generally used as mulch. The use of mulch will encourage the development of better root system of young litchi plants.

Pest management

Major pests and diseases and their control:

Name of pest	Control measures	
	Name of pesticide /treatment	Rate per litre of water
Litchi mite	Vertimec Or O'mite 57 EC	1.5 ml/l 1.8 ml/l 2 spray-at 15 days interval starting from emergence of new leaf
Litchi fruit borer	Cypermethrin (Cymbush/Basathrin /Fenom or other) 10 EC or Sumicidin 20 EC or Decis 2.5 EC	1.5 ml/l 2 spray-one at pea stage and another one 15-20 days before harvesting
Powdery mildew	Thiovit/Cumolax/Sulfolac Or Tilt 250 EC	2.0 g/l 0.5 ml/l 2 spray-one at flower bud emergence and another one at fruit set (pea) stage
Bat	Drive away of the pest making sound or focusing torch light	-

3.4 Harvesting and Fruit preservation

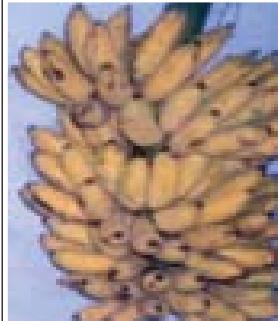
Quality of litchi fruits depends on the stage of harvest; because litchi is a non-climacteric fruit and does not improve in quality after harvest. Maturity of fruit is judged by colour development, flatness of tubercles and comparative smoothness of the epicarp. The fruit colour changes from greenish to pinkish red colour. The development of red pigmentation was found to be associated with anthocyanin pigment. Generally, fruit are harvested at about 55-60 days after fruit set. Fruit are harvested in May-June in bunches with few leaves. This is said to prolong the storage life of the fruit and at the same time the tree receives mild pruning. If the individual fruit is harvested, the skin at the stem end is ruptured causing the fruit to rot quickly. The fruits should not be harvested immediately after rains when the trees are wet as the spoilage of the fruit in storage would be high. Harvesting should be done in the cool part of the day preferably in late afternoon. Harvested fruit must not be kept under direct sun.

4. Banana

Banana is very nutritious among all other fruit particularly in the tropical region. It is one of the fruit which is available throughout the year. This crop is widely cultivated in Bogra, Jessore, Barisal, Rangpur, Mymensingh districts etc. In Bangladesh, its area is 53 thousand hectares and production is 8.08 lac metric tons in a year (BBS, 2011). The average yield of banana is 15.60 tons/ha. Its nutrient value such as calorie, vitamin and minerals is very high. The average yield of banana is higher than any other fruit and crops.

4.1 Varieties

A lot of varieties of banana are available in Bangladesh. Banana can be classified into two types based on use i.e. table banana and plantain. Amritsagar, Sabri, Kabri, Champa, Nepali and Rangin sagar are grown commercially in different parts of Bangladesh. BARI has developed four HYV of banana. Some salient features of these varieties are described below:

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Kola-1 (2000)	Individual bunch weight: 25 kg and contains 8-11 hands with 150-200 fingers. Individual fruit weight: 125g, fruit colour bright yellow and good in taste (TSS 24%). It is grown throughout the country. Generally, its growing season is September –January. Fruit yield: 50-60 t/ha and Duration: 11-12 months.	
BARI Kola-2 (2000)	High yielding introduced hybrid plantain variety. This variety is resistant to Panama and Sigatoka leaf spot disease. The plants are semi dwarf, strong and robust. Bunch weight: 15-20 kg, individual fruit weight: 100g and deep green in colour, number of fruit/bunch: 100-110. It is suitable for cultivation all over Bangladesh. Fruit yield: 35-40 t/ha and Duration: 11-12 months.	
BARI Kola-3 (2005)	It is popularly known as Bangla kola. It is high yielding variety of Kabri banana, Fruit are cylinder in shape, medium long (12-13 cm); number of fruits/bunch: 140-150, bunch weight: 23-25 kg, individual fruit weight: 144g. It is yellow in colour when ripened, seedless, very sweet (TSS 25.5 %) and tasty. It is tolerant to common insect pests and diseases and especially suitable for greater Sylhet, Chittagong and hilly areas. Fruit yield: 50 t/ha and Duration: 11-12 months.	

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Kola-4 (2006)	High yielding variety of Champa banana. Medium statured plant having height: 294 cm. Fruits are medium in size. Number of fruit /bunch: 178, bunch weight: 19 kg; individual fruit weight: 97g, ripe fruit yellow in colour, seedless and sour sweet in taste (TSS-20%). It is tolerant to common insect pests and diseases. Possesses export potentiality. This variety is cultivated throughout the country. Fruit yield: 47 t/ha and Duration: 11-12 months.	

4.2 Production Technology

Land and soil

Medium high land to high land with proper drainage facilities should be selected. For successful cultivation of banana, soil should be at least 60-80 cm depth, fertile loam and sandy loam soil with adequate sunlight. It can also be grown in different types of soil. The optimum soil pH 6.0-7.5 is suitable for banana growth.

Time of transplanting

Planting of banana should be done before or after monsoon i.e. May-June and September-October. Planting can also be done successfully in February-March if irrigation facilities are available.

Sapling collection

Sword sucker having narrow, slender leaf like sword with big rhizome, vigorous growth, about 50 to 60 cm height and 1.5-2.0 kg in weight should be selected for planting. Nowadays, heading back of tall sucker is beneficial. Suckers are produced commercially through tissue culture. The tissue cultured saplings establish quickly with low mortality rate and uniform growth. Besides, banana can be harvested within a short period compared to normal sucker. Moreover, tissue culture saplings are virus disease free. Sapling should be collected from the reliable nursery or from Government farm.

Transplanting method

Square or Hexagonal system is suitable for plain land and contour or terrace system for hilly region.

Spacing: For dwarf varieties 1.5 x 1.5 m (row x plant)

For tall and semi tall varieties 2.0 X 2.0 m (row x plant)

Pit Size: 45 x 45 x 45 cm³

Transplanting: After land preparation with desirable tilth, clods should be broken and weeds are removed. Then pits are dug maintaining a distance of 1.5 to 2 m. The pits are filled with well mixed soil and 10 kg well rotten cowdung or manure, 400g TSP, 300g MP, 200g gypsum, 5g zinc sulphate and 5g boric acid per pit at 10-15 days before

transplanting. Then, selected suckers/tissue cultured plantlets should be transplanted into the pit. Irrigation should be done immediately after transplanting of sucker.

Fertilizer application

Banana responds to both manures and fertilizers. The dosages of fertilizers depend on the variety and initial soil fertility. For split application 500g urea and 300g MP per plant should be applied in four equal installments at two months interval commencing from two months up to six months after planting and one installment of urea and MP should be applied after flowering. Both urea and MP are mixed thoroughly and spread around the plant and incorporate into the soil with spade. Fertilizer should be applied 30 cm away from the base of the stem and up to area shaded by the plant. Adequate moisture should be maintained at least for 15 days after application of fertilizers.

Irrigation

Banana is a moisture loving plant. During dry season, the plants are to be irrigated at 10-15 days interval to maintain satisfactory moisture level in the soil. In fact, it requires irrigation throughout the year except during heavy rain. Proper drainage should be maintained during rainy season to avoid water logging.

4.3 Intercultural Operation

Desuckering: Desuckering is done after 4-5 months of transplanting. Depending on the variety it is continued up to flowering at certain interval. One selected sucker is allowed to grow as ratoon crop after flowering.

Weeding and mulching: Weeding is accomplished as and when required to keep the crop free from weeds and to keep the soil loose for proper aeration. Mulching should be done after irrigation at appropriate time to break the soil crust and to make the soil loose as well. In the banana field, it is essential to remove undesirable materials such as dried, diseased and decayed leaves, pseudostem after harvest, male bud, last end of inflorescence and withered floral parts etc.

Propping: All plants are supported by bamboo immediately after emergence of inflorescence for protecting them from bending or falling down due to heavy bunch load and damage by storm.

Earthing up: Earthing up is important particularly during rainy season which provides support to the base of the plant and also encourages development of new root system.

Intercropping: Planting of banana may be followed by planting of intercrops like brinjal, chilli, okra, radish, onion, potato, carrot, coriander, lentil, cabbage, cauliflower, spinach etc. during the initial growth stage depending on climatic condition. During intercropping additional fertilizer should be applied so that banana plant does not suffer from nutrient deficiency.

Ratoon crop: The yield of first ratoon is higher than the main crop. Besides the cost of production of ratoon crop is less than the main crop and the crop can be harvested earlier than the main crop. Continuous three ratoon crop is recommended. After that, yield becomes lower with increased insect pest and disease attack. At the time of main crop harvesting the plant should be cut down one meter above the ground level. Then all the suckers including the rhizome of mother plant should be removed except the selected sucker and exposed place should be filled up with soil mixed with manure and fertilizer. Immediately after this operation irrigation should be given. Other cultural practices should also be adopted as like as main crop.

Crop rotation: Banana should not be cultivated more than four times including ratoon crop in the same field, because of highly exhaustive in nature. As a result of banana cultivation the soil loses its fertility and yield becomes lower. Other crops like vegetables or fruits (except banana) are recommended in banana field to improve the soil health and good yield.

Pest Management

Major insects and control measures:

Banana leaf and fruit beetle

Adult beetle feeds the green parts of young leaves and skin of young fruit. As a result, small patches appear on the young leaf and fruits. With the increasing size of fruits, the spots become larger and turn blackish brown in colour. The skin of banana looks like pox spot which reduces the market price.



Blackish brown like pox spot disease

Control measures:

- Clean cultivation. The inflorescence should be covered with perforated polythene bag (transparent/ blue) immediately after shooting.
- Spray with Diazinon 60 EC @ 2 ml/l of water or Fenfen 20 EC @ 1.5 ml/l of water three times starting from emergence of inflorescence, after opening of first hand and after complete opening of banana bunches.



Covered with perforated polythene bag to protect banana

Major diseases and control measures:

Panama disease or Banana wilts

This is the most harmful disease of banana. It causes due to fungus (*Fusarium oxysporum*) which is soil borne and gets entry into the plant body through roots. It is most serious in poorly drained soil. Affected plants show sudden yellowing of lower

leaves, including leaf blade, petiole and later they hung around the pseudostem and wither. Black streaks appear on rhizomes and pseudostems. Sometimes, pseudostem splits longitudinally. Acidic alluvial soils favour the spread of disease. Sabri banana is very susceptible to this disease.



Panama disease

Control measures:

- Uproot all affected plants and destroy them.
- Use disease free planting material.
- Avoid banana planting on infested soil at least 3-4 years.
- Use disease resistant cultivar/variety.
- Apply lime by mixing with soil (1:3) in the pit and near the base of the plant.

Leaf spot or Sigatoka disease

Symptom: It is a fungal disease. The first symptom of infestation is the presence of light yellowish spots on the young leaves. After that the spots enlarge, become oval and the colour also changes to dark brown. In severe cases, the numerous spots coalesce and covering large parts of the leaf. The yield may reduce up to 10-15%.



Leaf spot disease

Control measures:

- Use disease resistant cultivar/variety.
- Remove severely infected leaves or parts of leaves and destroy them.
- Proper spacing should be maintained so that all the plants can get sufficient air and sunlight.
- Spray with Score or Tilt @ 0.5 ml/litre of water or Nowin or Bavistin @ 2 g/l of water or Aconazol/Folicor @ 0.1 ml/l of water 2-3 times at 10-15 days interval immediately after disease symptom appear on leaves.

Bunchy Top

It is a virus disease and is spreaded by aphid. Infected plants show short, narrow and upright leaves at the top of the pseudostem, bunched together into a rosette form. The margin of the leaves become wavy and slightly rolled upward. There is an extreme reduction in size of the leaves and leaf petiole. The results are stunted growth of whole plant, which does not produce bunch of any commercial value.



Bunchy Top virus disease affected plant parts

Control measures:

- Remove all affected plants along with complete rhizome and destroy.
- Use any resistant variety/cultivar (BARI Kola-3) or virus free planting material.
- Spray with Emidacloprid (Admire 200 SL) @ 0.25 ml/l of water or Ripcord 1 ml/l of water at 15 days interval to control banana aphid.
- Avoid using sucker from affected plant.

Heart rot:

It is a minor bacterial disease. The flag leaf of the plant show blackish and decays.

Control measure:

- Remove all affected plants and destroy.
- Use disease free suckers.
- Ensure good drainage facilities, proper spacing and sufficient air and sunlight.

Nematode

The burrowing nematode lay eggs in the root tissue, after hatching out, larvae also feed on root. Small dark black spots appear on the roots and decays. Fungus and bacteria easily enter into root and affect the plant. Affected banana plants are unable to uptake nutrients and water from the soil. Plant growth and yields are affected adversely.



Nematode disease

Control measures:

- Follow crop rotation for 2-3 years.
- Use nematode resistant variety.
- Adopt phytosanitary measures.
- Apply Furadan 5G or Bistaben 5G @ 45-60kg/ha or Ragby 10G @ 30 kg/ha 3-4 times per year.

4.4 Harvesting and Fruit preservation

Fruits are harvested when they are green but fully mature. Maturity symptoms are: the colour of the fruit changes from deep green to a lighter green; shedding of floral ends of the fruits with slightest touch i.e. when it dry; the angle or ridges of the fruits become less prominent or round i.e. after the attainment of 3/4th full stage. Depending on season generally all seedless or less seeded banana varieties mature within 11 to 15 months after planting. But seeded variety requires 20-24 months for maturity. Harvesting is performed by cutting the bunch, retaining 15-20 cm stalk, this will help in handling. Bunch should not put in hard place or soil after harvest to avoid black spots on banana because the spotted banana is rotten quickly during ripening and consequently the market value is reduced.

5. Jujube (Ber)

Jujube (Ber) is one of the most nutritious fruit in Bangladesh. It has its taste and nutrient value. This crop is cultivated in all districts but good quality crop is grown mainly in Rajshahi, Comilla, Khulna, Barisal and Mymensingh. The total area and production of ber is respectively 1.12 thousand hectares and 78.2 thousand metric tons (BBS, 2011). It is a good source of minerals, vitamin A and vitamin C. This crop can be eaten both in green and ripened stage. Scented ketchup, different types of sauces are made from ber and these are very tasty.

5.1 Varieties

Comilla kul, Narikeli kul, Rajshahi kul and Apple kul are cultivated in different parts of the country. Bangladesh Agricultural Research Institute (BARI) has developed three improved varieties of ber whose salient features are given below:

Name of Varieties (Year of Release)	Important Characteristics	Crop
BARI Kul-1 (2003)	High yielding regular bearing variety. Trees are medium in height and medium spreading. Flowering appears in September and harvesting starts at 2 nd week of February. Fruit are medium, fruit weight: 23g, oblong but pointed at the lower end, yellowish green. Pulp is white, crispy, very sweet (12-13% TSS) and delicious, devoid of astringency. Seed is small and edible portion: 92%. The variety is suitable for growing at Rajshahi and Khulna region and possesses export potentiality. Fruit yield: 10-12 t/ha.	
BARI Kul-2 (2003)	High yielding regular bearing variety. Trees are medium in height and medium spreading. Flowering appears in September and harvesting starts at last week of January. Fruit are medium, fruit weight: 34g, oval in shape, sweet (11.5% TSS) and tasty. Seed is small and edible portion: 91%. This variety is suitable for cultivation all over Bangladesh and possesses export potentiality. Fruit yield: 18-20 t/ha.	
BARI kul-3 (2009)	High yielding mid-season variety. Trees are dwarf and more or less straight. Flowering appears in September and harvesting starts at 2 nd week of January. Fruits are big and average weight of each fruit: 75g, shape is ovate oblong. Pulp is white, very juicy, crispy, very sweet (14% TSS), devoid of astringency. Seed is small, edible portion: 96%. It is suitable for cultivation all over Bangladesh and possesses export potentiality. Fruit yield: 22-25 t/ha	

5.2 Production Technology

Land and soil

High land with proper drainage is suitable for ber cultivation. Ber can be grown in a wide range of soil including a porous and infertile soil which is unsuitable for other fruits crops. It can successfully be grown in saline and alkaline soil as well. It can tolerate drought as well as water logged condition. However, loamy to sandy loam soil with pH 6.5 to 7.5 is the best.

Time of planting

The best time for ber planting is June-July (beginning of monsoon) and September-October. Besides, planting can be done in any time of the year except winter with assured irrigation.

Sapling collection

During selecting of planting materials the following points should be considered: i) improve variety from the authentic source of scion. ii) Sapling should be 1-2 years old, good vigour, uniform growth with 2-3 branches. iii) Good compatibility between scion and rootstock and free from pest and diseases. The sapling should be collected from the reliable nursery or Government farm.

Transplanting method: Square or Hexagonal system.

Spacing: Spacing depends upon soil types, pruning operation, varieties and climatic conditions. But in general, it is followed: (4-6 m x 4-6 m (plant x row).

Pit size: 1x1x 1m³

Transplanting

On well prepared land, the spots are marked and pits are dug in April-May for monsoon planting and August-September for post monsoon planting. The pits are filled up with uniformly mixed top soil and 25kg well rotten cowdung, 250 g TSP, 250g MP and 250g Gypsum per pit.

Fertilizer application

Fertilizer and manure should be applied regularly to have proper growth and higher yield. The doses of fertilizer depend on age of tree and soil fertility status. Fertilizer doses for different ages of tree are given below.

Requirement of manures and fertilizers per tree (year to year doses of nutrients) are as follows:

Plant age (year)	Quantity of manures and fertilizer per tree			
	Cowdung (kg)	Urea (g)	TSP (g)	MP (g)
1-2	10	300	250	250
3-4	15	500	400	400
5-6	20	750	700	700
7-8	25	1000	850	850
9 and above	30	1250	1000	1000

Besides these, fertilizer and manure which are deficit in regional basis should be applied. The aforesaid manure and fertilizers should be applied in two equal installments in May-June and September-October (after fruit set), respectively. Fertilizers should be mixed uniformly with the soil followed by irrigation. Generally in adult tree, application of fertilizer should be done starting from 1-1.5 m away from the base of the tree up to the area shaded by the plant and confined with 3.5 m of the canopy of the tree. Dibbling method may be followed where fertilizer application is difficult.

Irrigation

Ber is grown successfully on dry climate. However, for better survival and establishment of newly planted ber plants, light irrigation should be given. During dry season especially at the fruit development stage, it needs irrigation for better fruit development and quality improvement. Irrigation should be given at one month interval from October to February depending on the moisture status of the soil.

5.3 Intercultural Operation

Training and pruning

Training of ber tree is essential during first 2-3 years to build up a strong framework. New shoot develop from the rootstock should be removed regularly. Bamboo sticks are fixed for support and straight growth of the tree. While pruning, care should be taken so that there is no branch below one metre height of main stem. Above one metre, the 4-5 branches spreading in all directions should be allowed to ensure the tree to grow in good and balanced shape.

The fruits of ber are born on the axil of leaves on the young shoots of current season. Therefore, annual pruning is necessary immediately after fruit harvest to induce healthy shoots which provide maximum fruit bearing area on the tree. Medium pruning is recommended up to 3-4 years old tree i.e. heading back 50-60 cm from the top of the branches and branchlets. After the tree attains the desirable size and shape, one year old branches should be heading back (pruned) leaving 20-30 cm from the base of the branch. Besides, weak, thin, diseased, broken and intercrossing/criss-cross branches should be removed with a sharp secateurs or pruning shear during pruning.

Intercropping

After planting ber, 4-5 years are required to cover the interspaces between the trees. Generally, leguminous crops are preferred as intercrop as they enrich soil in addition to some income. Under irrigated conditions vegetables and chillies can be grown. In suitable climatic condition, papaya can be grown as intercrop in the first three years.

Weeding

In order to keep the ber plantation free from weeds, regular hoeing is advised. Always shallow cultivations are done. Whenever root-suckers are found, they should be removed because they reduce the yield potential of ber tree.

Pest Management

Major insects and control measures:

Leaf chafer

Beetles feed on leaves mainly during night. The leaves become just like a sieve. The severe attack is found during rainy season when new flush is produced.



Leaf chafer

Control measures:

- Spray with Sumialpha/Sumithion @ 2 ml/l of water two times at an interval of 10 days.
- Besides, weeds should be removed around the tree and apply Chloropyriphos (Pyrifos 20EC/ Dursban 20EC) in the soil @ 5 g/l of water.

Ber nut weevil

Nut weevil is a new pest and has become a serious threat to ber cultivation. About 50% fruits are found to be infested by the pest. The weevil feed only on the seed portion of developing fruit and arrest further development of fruit.



Ber nut weevil

Control measure:

- Clean cultivation. Destruction of bushes from the orchard, collection and destruction of infested fruit before emerging adults from the fruit.
- Spray of cypermethrin @ 1.5 ml/l of water at initial stage of setting at 10 days interval.

Fruit fly

It is the most serious pest of ber. The adult female lay eggs by inserting its ovipositor in developing mature fruit. After 2-5 days, larvae feed on pulp. Infested fruit becomes unfit for eating and drop down.



Fruit fly

Control measures:

- Collect the infested fruit and destroy them completely.
- Ploughing orchard should be done during summer to expose the hibernating pupae to the sun and birds.
- Spraying of the trees with Ripcord/Cymbush 10EC @ 1 ml/l of water or Desis @ 0.5 ml/l of water 2-3 times should be applied at an interval of 10-15 days.

Tube spittle bug

This is a new threat to ber farmers. In 2010, it was recorded first time at Bogra Zila in northern region of Bangladesh. 100% crop may be damaged by this pest if it is not noticed at early stage of flowering. Nymphs of the bug suck sap from flower. Affected flowers are dried completely and unable to bear fruit. Heavy infestations can cause complete failure of the crop. Nymphs construct calcareous tubes in which they live and feed.



Tube spittle bug

Control measures:

- Clean cultivation.
- Hand picking and destruction of tube with bug.
- Spray with Fenitrothion (Sumithion/Folithion/Fenitox 50EC @ 1.5 ml/l of water at 10 days interval.

Major diseases and control measures:**Powdery mildew**

Generally the disease appears in September-October. Affected fruits show white powdery spots which later cover whole area of fruit. The white powdery mass also spread on flowers and leaves. Later white spots turn to brown and flowers and fruit drop down. Fruits crack if the fungus attacks at the mature stage.



Powdery mildew

Control measure:

- The orchards should be clean.
- Spray the tree at the time of flowering with Thiovit/Salfolac/Kumolux @ 2 g/l of water 2-3 times at an interval of 10-15 days.

Fruit rot

Infection starts with light brown spots on the apical end of the fruit and later whole area of the fruit is covered and they turn dark brown in colour. The amount of vitamin C is decreased and harmful alpha toxin develops due to attack of this pathogen.



Fruit rot

Control measure:

- Collect the affected fruit and destroy them.
- Spray 2-3 times with Indofil M-45 @ 2 g/l of water at an interval of 10-15 days.

Sooty mould

Appearance of black spots on the lower surface of the leaves and in advanced stages the entire lower surface may be covered by sooty mould and the leaves may drop down.



Sooty mould

Control measures:

- Clean cultivation, collection and burning of shaded leaves should be done.
- Insecticide Bavistin @ 1g per litre of water 2-3 times should be sprayed at 10-15 days interval.

5.4 Harvesting and Fruit preservation

The fruits are plucked up at right stage of maturity i.e. when the colour of the fruits changes from green to yellowish or golden. Care should be taken so that any injury or cracking of fruits does not occur during fruit harvest. Cool weather of morning or late afternoon is more suitable for fruit plucking. This practices enhances shelf life of Ber to some extent.

6. Papaya

Papaya is one of the most important fruit in the world. It is also a very important and popular in Bangladesh. Some salient features of papaya crop are: (1) it is a short duration crop; (2) it is widely used not only as fruit but also as vegetables and (3) this crop is very tasty, nutritious and used for medicinal purpose. The good quality of papaya crop is mainly grown in greater Rajshahi, Pabna and Jessore. At present in our country, its area and production are about 1.24 thousand hectares and 1.25 lac metric tons, respectively (BBS, 2011). The average yield of papaya is 7 ton/ha. Ripe papaya is a good source of vitamin A which is next to mango.

6.1 Varieties

A lot of variability of papaya is available in Bangladesh. BARI has developed only one improved papaya variety whose salient features are described below:

Shahi pape

It is a high yielding dioecious variety. The plant is medium in height (1.6 to 2.0 m), fruit born low on the stem. Fruits are medium size, **fruit weight:** 800-1000g, oblong in shape, **seeds per fruit:** 500-550. **The flesh thickness:** 2.5 to 3.0cm. Colour is deep orange-red. **Fruit/plant:** 40-60 and very sweet in taste (TSS 12%). It is suitable for cultivation all over Bangladesh. **Fruit yield:** 40-60 t/ha and **Duration:** 10-11 months.



Shahi Pape

6.2 Production Technology

Land and soil

Medium to high land with proper drainage facilities is suitable for papaya cultivation. Deep soil enrich in organic matter having good drainage facilities is good for papaya production. However, loamy to sandy loam soil with rich in plant nutrients and well drained are the best. The crop is very suitable for cultivation when soil pH ranges from 6.0 to 7.0. It does not survive in water logging condition.

Time of transplanting

September-October and December-January is the best time for seed sowing of papaya. The seedlings are suitable for transplanting at 40-50 days after seed germination.

Seedling raising

Healthy seedlings are the pre-requisite for good crop. Papaya seedlings should be grown in pots or in the seed beds.

In pots: Polythene or plastic pots are used for raising seedlings. 12 x 8 cm size pot with 3-4 holes at the bottom is filled with prepared potting media. The potting media is prepared with the mixture of river silt and well decomposed cowdung in equal proportion. Two to three seeds are sown per pot at 1cm depth in the media of the pot at least 55-65 days before transplanting in the main field. The pots are watered regularly to keep the media moist for higher germination. The pots are used to keep in the warm place of the net house. Scorch sunlight is not advocated for seed germination. The moisture of the potting media should be maintained and excess water should be drained out from the pot. Seedlings raised in pot are suitable to transfer in the distant places.

In seed beds: The seeds are sown in seed bed maintaining 10-15 cm row to row distance, 3-4 cm from seed to seed in a depth of 1.0-1.5 cm. The seedlings are uprooted with minimum damage of roots just before planting. Even 2nd transplanting should be done from seed bed to pot just 7-10 days after germination.

Sapling collection

Sapling or seed should be collected from a reliable nursery, Government farm or seed company.

Transplanting method:

Square system
Spacing: 2 m x 2 m (plant x row)

Pit size: 60 x 60 x 45 cm³

Transplanting: First of all, field is well ploughed and harrowed, after then; pits are dug maintaining 2 x 2 m distance. The pits are filled with well mixed soil and 15 kg well rotten cowdung or compost, 500 g TSP, 250 g gypsum; 20 g zinc sulphate and 20 g boric acid at 10-15 days before transplanting and kept moist by watering. Then, transplanting of 40-50 days old seedling is done in the evening hours. Just after planting, seedling are provided with support and watered soon. In case of dioecious varieties like Shahi usually three seedlings should be planted per pit.

Fertilizer application

Fertilizers should be applied in time to achieve good yield. The dosages of fertilizers should be applied depending on the variety and initial soil fertility. 450-500 g urea and 450-500 g MP per plant should be applied as split application. 50g urea and 50g MP should be applied per plant one month interval commencing from one month after planting. The fertilizer dose should be double after flowering. Both urea and MP are mixed thoroughly and spread around the plant and incorporating into the soil with spade. Fertilizer should be applied 30 cm away from the base of the stem and up to the area shaded by the plant at noon. Each application should be followed by light irrigation.

Irrigation

Light and frequent irrigation is needed during dry season. Generally, papaya crop is irrigated at 10-15 days intervals in winter and 5-7 days in drought condition

depending upon the moisture status of soil. Satisfactory drainage facilities should be maintained to drain out excess water during irrigation and rainy season.

6.3 Intercultural Operation

Removal of excess plants: When flowering starts after 3-4 months of planting, it becomes very easy to uproot male plants from dioecious papaya varieties. About 5-10% male plants are allowed for pollination. In the row one male plant should be left against 10 to 20 female plants. Generally single robust plant is left per pit.

Weeding: The land should be free from weeds all the time. At the time of weeding, care should be taken to ensure that soils are not made too loose during rainy season.

Earthing up: Earthing up of the papaya plant should be done especially during rainy season. This provides support to the plant to remain in erect position.

Fruit thinning: More than one flower and fruit come out from the leaf axil of most of the papaya varieties. Fruit should be thinned out retaining one healthy fruit per axil to allow adequate space for attaining good size of the fruit.

Propping: All plants should be stacked by bamboo immediately after flowering starts for protecting them from falling down due to heavy weight of fruit per axil and from any damage by wind.

Pest Management

Major insect and control measures:

Mealy bug

Mealy bug has recently emerged as a major threat to different crops especially papaya in many regions of Bangladesh causing serious economic loss. The pest is small in size, oval shape; their body is covered with white waxy materials. They suck sap from young leaves, twigs, flower and fruit. They inject a toxic substance into the leaves. The result is chlorosis, stunted plant growth, leaf deformation, early leaf and fruit drop and sooty mould.



Affected by Mealy bug

Control measures

- The affected leaves including insect should be destroyed at the initial stage of attack or the insect should be rubbed with tooth brush and destroyed.
- In case of severe infestation, spraying 2-3 times at 10-15 days interval with soap water @ 5 g/l or Admire 200SL @ 0.25 ml/l of water.

Major diseases and control measures:

Damping off and Collar rot

This disease is common in nursery bed. Water soaked patches are found on the stem which gradually enlarge and girdle the base of the stem. The affected area turns black and rots. Then seedlings are topple down on the ground with the constriction at the ground level. This disease is more serious during rainy season.



Damping off and
Collar rot

Control measures

- Remove and burn affected plants and provide good drainage facilities.
- Soil of seed bed should be sun dried properly before seed sowing.
- Treat the seed before sowing with Secure 2-3 g/kg of seed.
- Half rotten poultry refuse should be applied for soil amendment @ 5 ton/ha before 15-21 days of seed sowing.
- Disease severity can also be reduced by applying Secure @ 2 g/l of water in the soil through drenching.

Anthracnose

Brown colour rot is seen on the surface of the fruit and the fruit become unfit to eat.



Anthracnose disease

Control measures

- Spray Nowin/Bavistin/Kadazim @ 2 g/l of water two to three times at an interval of 10-15 days.

Papaya Mosaic virus

It is very wide in occurrence. The affected plants become stunted, leaves become yellow and petioles show bending downward. Different types of aphids act as vector.



Affected by Mosaic virus

Control measures

- Uproot affected plants and burn them immediately.
- Insecticide Admire 200SL @ 0.25 ml/l of water at 15 days interval should be applied to control aphid.

Papaya leaf curl virus

Affected leaves show curling, crinkling and distortion. The size of the leaf is reduced considerably. The disease is transmitted through white fly.



Leaf curl virus

Control measures

- Uproot affected plants and burn them.
- Admire 200 SL @ 0.25 ml/litre of water at 15 days interval should be applied to control white fly.

Rootknot nematode

The nematode lay eggs in the root tissue, after hatching out, larva also feed on the root. Affected root swollen and form knot. Plants become weak; growth is stunted and leaves show yellowish colour and then dry off.



Affected by Root knot nematode

Control measures

- Follow crop rotation for 2-3 years.
- Apply Furadan 5 G @ 5 g/plant 3-4 times per year.
- Apply half rotten poultry refuge or mustard oilcake @ 3 t/ha or 300 kg/ha and mixed with the soil uniformly three weeks before planting.

Nutrient deficiency problem

Boron deficiency

Papaya is very sensitive to boron. Affected leaves show curling, sometimes develop only midrib without lamina, Latex exudates from the fruit and fruit are irregular and bumpy in shape.



Affected by Boron deficiency

Control measures:

- 20 g boric acid or 50 g borax should be applied at the time of pit preparation. All the leaves should be sprayed with boric acid or borax @ 2 g or 5 g/liter of water two to three times at 10-15 days interval, if the deficiency symptom appears even adding boron in the pit.

6.4 Harvesting and Seed preservation

When the latex become thin and watery papaya is suitable for harvest for vegetable purpose. On the other hand, mature fruit showing a tinge or 5-10% yellow colour appear on the fruit surface are ready for harvest. If the fruit are allowed to ripe, they are often damaged by birds. The individual fruit is harvested with hand. Fruit are not allowed to fall on the ground or come in contact with the soil while plucking. Seeds are collected from the well ripen fruits. The seeds are rubbed with hand to remove seed coat and washed with clean water. Seeds are dried in shade to reduce moisture. Then seeds are stored in air tight container or desiccators.